

**PATENT**

1. A compact gas burner apparatus having a short flame length and a high  
5 turndown ratio for discharging a mixture of fuel gas and air into a furnace space  
wherein the mixture is burned and flue gases having low NO<sub>x</sub> content are formed  
therefrom comprising:

a housing having an open end attached to said furnace space;

10 means for introducing a controlled flow rate of said air into said  
housing attached thereto;

a burner tile attached to the open end of said housing having an  
opening formed therein for allowing said air to flow therethrough and having a wall  
surrounding said opening which extends into said furnace space, the exterior sides of  
said wall being divided into sections by a plurality of radially positioned baffles  
15 attached thereto with alternate sections having different heights and slanting towards  
said opening at different angles and one or more of the alternating sections having a  
primary fuel gas passageway formed therein for conducting primary fuel gas from  
outside said section to within said wall; and

a plurality of fuel gas nozzles connected to said source of fuel gas and  
20 positioned outside said wall of said burner tile for discharging secondary fuel gas  
adjacent to said external slanted wall sections with one or more of said fuel gas  
nozzles also discharging primary fuel gas mixed with flue gases into and through said  
primary fuel gas passageways whereby said secondary fuel gas mixes with flue gases  
in said furnace space, the mixture of secondary fuel gas and flue gases mixes with  
25 unburned air, primary fuel gas and flue gases flowing through said opening and wall  
of said burner tile, and the resultant mixture is burned in said furnace space.

2. The burner apparatus of claim 1 wherein said radially positioned  
baffles attached to said burner tile extend in directions parallel to the axis of said  
30 burner tile wall whereby said secondary fuel gas and flue gases are divided into a  
plurality of separate streams which mix with said primary fuel gas and unburned air  
flowing through said opening and wall of said burner tile.

3. The burner apparatus of claim 1 wherein a first of said alternating wall sections has a short height and slants towards said opening in said burner tile at a large angle, the second of said wall sections has the same or a taller height and slants towards said opening at the same or a smaller angle and successive alternating sections have heights and angles which are the same as said first and second sections.

4. The burner apparatus of claim 3 wherein said first of said alternating sections have heights in the range of from about 0 inches to about 16 inches and slant towards said opening at an angle in the range of from about 0 degrees to about 90 degrees, and the second of said alternating sections have the same or different heights as the first of said alternating sections in the range of from about 2 inches to about 16 inches and slant towards said opening at the same or different angles in the range of from about 0 degrees to about 60 degrees.

5. The burner apparatus of claim 3 wherein said first of said alternating sections have heights in the range of from about 5 inches to about 10 inches and slant towards said opening at an angle in the range of from about 10 degrees to about 30 degrees, and the second of said alternating sections have the same or different heights as the first of said alternating sections in the range of from about 6 inches to about 12 inches and slant towards said opening at the same or different angles in the range of from about 5 degrees to about 15 degrees.

6. The burner apparatus of claim 3 wherein said first of said alternating sections have heights of about 7 inches and slant towards said opening at an angle of about 20 degrees, and the second of said alternating sections have heights of about 9 inches and slant towards said opening at an angle of about 10 degrees.

7. The burner apparatus of claim 3 wherein said passageways are located in said slanted wall sections which have short heights and slant towards said opening in said burner tile at large angles, said passageways being positioned whereby primary fuel gas discharged from said fuel gas nozzles mixes with flue gases and flows

through said passageways into the interior of said wall of said burner tile wherein the mixture mixes with air.

5           8.       The burner apparatus of claim 1 wherein said burner tile, said opening therein and the interior of said wall of said burner tile are substantially circular, rectangular, square, triangular, polygonal or other shape.

10           9.       The burner apparatus of claim 1 wherein said open end of said housing is circular, square, triangular, polygonal or other shape and said housing is cylindrical, square, rectangular, triangular, polygonal or other shape.

15           10.      The burner apparatus of claim 1 which optionally further comprises a primary fuel gas nozzle connected to a source of fuel gas positioned within said opening and wall of said burner tile for mixing additional primary fuel gas with said air flowing through said burner tile and discharging the mixture into said furnace space.

20           11.      The burner apparatus of claim 10 which optionally further comprises a venturi positioned around and above said additional primary fuel gas nozzle.

          12.      The burner apparatus of claim 1 which optionally further comprises a flame stabilizing surface within said opening of said burner tile.

25           13.      The burner apparatus of claim 2 wherein said separate streams of secondary fuel gas and flue gases mixed with said unburned air and primary fuel gas are burned in said furnace space in a folded flame pattern which produces flue gases having low NO<sub>x</sub> content.

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14. A compact gas burner apparatus having a folded flame pattern, a short flame length and a high turndown ratio for discharging a mixture of fuel gas and air into a furnace space wherein the mixture is burned and flue gases having low NO<sub>x</sub> content are formed therefrom comprising:

5 a housing having an open end attached to said furnace space;  
an air register for introducing a controlled flow rate of air into said housing attached thereto;

10 a burner tile attached to the open end of said housing having an opening formed therein for allowing said air to flow therethrough and having a wall surrounding said opening which extends into said furnace space, the exterior sides of said wall being divided into sections by a plurality of radially positioned baffles attached thereto with alternate sections having the same or different heights and slanting towards said opening at the same or different angles, a first of said alternating wall sections having a short height and slanting towards said opening at a large angle,  
15 the second of said wall sections having the same or a taller height and slanting towards said opening at the same or a smaller angle and successive alternating sections having heights and angles which are the same as said first and second sections, every other of said slanted wall sections also having passageways formed therein for conducting primary fuel gas and flue gases into the interior of said wall;  
20 and

a plurality of fuel gas nozzles connected to said source of fuel gas and positioned outside said wall of said burner tile for discharging secondary fuel gas adjacent to said external slanted wall sections whereby said secondary fuel gas mixes with flue gases in said furnace space and the resultant mixture mixes with unburned  
25 air, primary fuel gas and flue gases flowing through said opening and wall in said burner tile, and is burned in said furnace space, and a portion of said fuel gas nozzles discharging primary fuel gas mixed with flue gases through said every other passageway in said slanted wall sections into the interior of said burner tile wherein said primary fuel gas and flue gases mix with air therein.

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15. The burner apparatus of claim 14 wherein said radially positioned baffles attached to said burner tile extend in directions parallel to the axis of said burner tile wall whereby said secondary fuel gas and flue gases are divided into a plurality of separate streams which mix with said primary fuel gas and unburned air flowing through said opening and wall of said burner tile.

16. The burner apparatus of claim 14 wherein said first of said alternating sections have heights in the range of from about 0 inches to about 16 inches and slant towards said opening at an angle in the range of from about 0 degrees to about 90 degrees, and the second of said alternating sections have the same or different heights as the first of said alternating sections in the range of from about 2 inches to about 16 inches and slant towards said opening at the same or different angles in the range of from about 0 degrees to about 60 degrees.

17. The burner apparatus of claim 14 wherein said first of said alternating sections have heights in the range of from about 5 inches to about 10 inches and slant towards said opening at an angle in the range of from about 10 degrees to about 30 degrees, and the second of said alternating sections have the same or different heights as the first of said alternating sections in the range of from about 6 inches to about 12 inches and slant towards said opening at the same or different angles in the range of from about 5 degrees to about 15 degrees.

18. The burner apparatus of claim 14 wherein said first of said alternating sections have heights of about 7 inches and slant towards said opening at an angle of about 20 degrees, and the second of said alternating sections have heights of about 9 inches and slant towards said opening at an angle of about 10 degrees.

19. The burner apparatus of claim 14 wherein said burner tile, said opening therein and the interior and said wall of said burner tile are substantially circular, rectangular, square, triangular, polygonal or other shape.

20. The burner apparatus of claim 14 wherein said open end of said housing is circular, square, triangular, polygonal or other shape and said housing is cylindrical, square, rectangular, triangular, polygonal or other shape.

5 21. The burner apparatus of claim 14 which optionally further comprises at least one primary fuel gas nozzle connected to a source of fuel gas positioned within said opening and wall of said burner tile for mixing additional primary fuel gas with said air flowing through said burner tile and discharging the mixture into said furnace space.

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22. The burner apparatus of claim 14 which further comprises a venturi positioned around and above said primary fuel gas nozzle.

15 23. The burner apparatus of claim 14 which further comprises a flame stabilizing surface within said opening of said burner tile.